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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/863,291	05/24/2001	Kazunori Anazawa	109593	9227

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EXAMINER	
LISH, PETER J	
ART UNIT	**PAPER NUMBER**
1754	

DATE MAILED: 03/09/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)
	09/863,291	ANAZAWA ET AL.
	Examiner	Art Unit
	Peter J Lish	1754

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 04 November 2003.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-3,8,9,11 and 15-19 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-3, 8-9, 11, and 15-19 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 11/04/03.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Applicant's arguments filed 11/04/03 have been fully considered but they are not persuasive. Applicant argues that the selection of a pressure of at least 39.9 kPa for the reaction gives way to unexpected results, namely the production of a dramatically increased yield of nanotube product. The document that the applicant relies upon, however, fails to show a dramatically increased yield of nanotube product, but rather shows regular plots of nanotube yield vs. reaction pressure. The plots were determined through routine experimentation in order to show the optimum reaction pressure. Therefore the plot further supports the argument that the selection of a specific pressure (taking into account the cost of high pressure vs. the yield of nanotube product) is the optimization of a known process, which could have been determined through routine experimentation. Furthermore, the applicant argues that Withers et al. teach a preferred pressure range of 100-200 torr and therefore teach away from the presently claimed invention. However, Withers teaches a general range which encompasses the pressures of the presently claimed invention, and the selection of a preferred pressure from within that range does not entail teaching away.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-3, 8, 11, and 15-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. (USPN 5,876,684) taken with Chiharu et al. (JP 11116218).

Withers et al. disclose a method for the production of fullerenes and nanotubes in a suitable heat generating system, such as a plasma zone created by an electric arc between two electrodes (See Figures 13a and 13b). In this method, a fluid that may be carbon particulates or hydrocarbon in a liquid or gaseous state are continuously fed to the reaction zone and supplied with heat from the source in an atmosphere and under other conditions that cause formation of fullerenes (column 2, lines 1-13). Because hydrogen can interfere with the fullerenes ring closure, hydrocarbons with low hydrogen/carbon ratios such as benzene, naphthalene, etc. are preferred (column 9, lines 60-67). Withers et al. also teach the process of evacuating the system to 10^{-3} torr before pressurizing the system and creating the arc (Example 1). Withers et al. do not however teach the formation of single-walled nanotubes, nor do they teach the use of a catalyst within the carbon feed.

Chiharu et al. teach the use of catalysts for the production of single-walled carbon nanotubes using various processes known for producing fullerenes. Chiharu et al. teach that single-walled carbon nanotubes can be produced by the plasma method, wherein a carbon component, such as petroleum oil, and metal nanoparticle catalysts, such as those comprising iron, cobalt, or nickel, are introduced into a plasma frame and the carbon materials exiting the plasma are cooled (paragraph [0018]). It would have been obvious to one of ordinary skill at the time of invention to add the catalyst materials of Chiharu et al. to the carbon feed of Withers et al. in order to produce single-walled nanotubes.

Withers et al. teach the use of a pressure within the range of 10^{-6} to 760 torr. The selection of a specific pressure range, such as that between 39.9 kPa (300 torr) and 79.8 kPa (600 torr), is determined to be the optimization of a known process, which could have been determined through routine experimentation, and is held to be obvious by *In re Boesch* 205 USPQ 215.

Claims 1-3, 8, 11, and 15-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. (USPN 5,876,684) taken with Chiharu et al. (JP 11116218) and further in view of Ebbesen ("Carbon Nanotubes Preparation and Properties").

Withers et al. disclose a method for the production of fullerenes and nanotubes in a suitable heat generating system, such as a plasma zone created by an electric arc between two electrodes (See Figures 13a and 13b). In this method, a fluid that may be carbon particulates or hydrocarbon in a liquid or gaseous state are continuously fed to the reaction zone and supplied with heat from the source in an atmosphere and under other conditions that cause formation of fullerenes (column 2, lines 1-13). Because hydrogen can interfere with the fullerenes ring closure, hydrocarbons with low hydrogen/carbon ratios such as benzene, naphthalene, etc. are preferred (column 9, lines 60-67). Withers et al. also teach the process of evacuating the system to 10^{-3} torr before pressurizing the system and creating the arc (Example 1). Withers et al. do not however teach the formation of single-walled nanotubes, nor do they teach the use of a catalyst within the carbon feed.

Chiharu et al. teach the use of catalysts for the production of single-walled carbon nanotubes using various processes known for producing fullerenes. Chiharu et al. teach that

single-walled carbon nanotubes can be produced by the plasma method, wherein a carbon component, such as petroleum oil, and metal nanoparticle catalysts, such as those comprising iron, cobalt, or nickel, are introduced into a plasma frame and the carbon materials exiting the plasma are cooled (paragraph [0018]). It would have been obvious to one of ordinary skill at the time of invention to add the catalyst materials of Chiharu et al. to the carbon feed of Withers et al. in order to produce single-walled nanotubes.

Withers et al. teach the use of a pressure within the range of 10^{-6} to 760 torr. However, Ebbesen teaches that in the arc discharge formation of single-walled carbon nanotubes, good yields are obtained at pressure around 500 to 600 torr. It therefore would have been obvious to one of ordinary skill to apply a pressure of between 500 and 600 torr in the process of Withers et al. in order to produce a high yield of single-walled nanotube product.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. taken with Chiharu et al. as applied to claim 1 above, and further in view of Journet et al. ("Large-scale production of single-walled carbon…").

Neither Withers et al. nor Chiharu et al. disclose the use of yttrium catalysts for the growth of single-walled carbon nanotubes in an electric arc process. Journet, however, teaches that a mixture of yttrium and nickel catalyst particles gives the highest yield of single-walled nanotubes in an electric arc process and that yttrium strongly favors the growth of single-walled nanotubes. It would have been obvious to one of ordinary skill at the time of invention to include the nickel and yttrium catalyst particles, taught by Journet et al., in the process of Withers taken with Chiharu in order to increase the yield of single-walled carbon nanotubes.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. taken with Chiharu et al. and in view of Ebbesen as applied to claim 1 above, and further in view of Journet et al. ("Large-scale production of single-walled carbon…").

Neither Withers et al. nor Chiharu et al. disclose the use of yttrium catalysts for the growth of single-walled carbon nanotubes in an electric arc process. Journet, however, teaches that a mixture of yttrium and nickel catalyst particles gives the highest yield of single-walled nanotubes in an electric arc process and that yttrium strongly favors the growth of single-walled nanotubes. It would have been obvious to one of ordinary skill at the time of invention to include the nickel and yttrium catalyst particles, taught by Journet et al., in the process of Withers taken with Chiharu in order to increase the yield of single-walled carbon nanotubes.

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. taken with Chiharu et al. as applied to claim 15 above, and further in view of Bethune et al. (US 5,424,054).

Neither Withers et al. nor Chiharu et al. explicitly teach the formation of the arc by a contact arc processing. Bethune teaches a process for the formation of single-walled carbon nanotubes using an electric arc. The arc is established by bringing the anode and the cathode into contact and then separating them by a short distance. It would have been obvious to one of ordinary skill at the time of invention to create the electric arc of Withers et al. using contact arc processing, as taught by Bethune et al., as it is an equivalent means of producing an electric arc capable of forming nanostructures.

Claim 19 is rejected under 35 U.S.C. 103(a) as being unpatentable over Withers et al. taken with Chiharu et al. and in view of Ebbesen as applied to claim 15 above, and further in view of Bethune et al. (US 5,424,054).

Neither Withers et al. nor Chiharu et al. explicitly teach the formation of the arc by a contact arc processing. Bethune teaches a process for the formation of single-walled carbon nanotubes using an electric arc. The arc is established by bringing the anode and the cathode into contact and then separating them by a short distance. It would have been obvious to one of ordinary skill at the time of invention to create the electric arc of Withers et al. using contact arc processing, as taught by Bethune et al., as it is an equivalent means of producing an electric arc capable of forming nanostructures.

Claims 1-2, 8-9, 11, 15-16, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zettl et al. (US 6,063,243).

Zettl teaches a method for the production of either single-walled or multi-walled carbon nanotubes by an arc-discharge reaction. An arc is produced across two electrodes, which may be made of tungsten. The electrodes have interior conduits for the delivery of materials in particulate, gaseous, or liquid form. The materials may aid the reaction by providing reactants or catalysts. The elements may be carbon reactants in liquid form, such as benzene, and catalytic metal powders such as iron, nickel, and yttrium. The reaction apparatus is maintained at a pressure between 100 and 1000 torr. The selection of a specific pressure, such as one between 39.9 kPa (300 torr) and 79.8 kPa (600 torr), from within the pressure range taught by Zettl et al.

is deemed to be the optimization of a known process, which could have been determined through routine experimentation, and is held to be obvious by *In re Boesch* 205 USPQ 215.

Zettl et al. teaches that the reaction is performed in a vacuum chamber, however, it does not explicitly teach that the chamber is brought to a pressure of below 1.3 Pa prior to the reaction. It would have been obvious to one of ordinary skill at the time of invention to bring the chamber under vacuum conditions, such as below 1.3 Pa, in order to ensure that the inert gaseous atmosphere in which the reaction takes place is uncontaminated.

Claims 3 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zettl et al. as applied to claims 1 and 15 above, and further in view of Chicharu et al.

Zettl et al. does not teach the use of petroleum liquid, mineral oil, or fatty acid esters as reactants. Chiharu et al. teach that single-walled carbon nanotubes can be produced by the plasma method, wherein a carbon component, such as petroleum oil, and metal nanoparticle catalysts, such as those comprising iron, cobalt, or nickel, are introduced into a plasma frame and the carbon materials exiting the plasma are cooled (paragraph [0018]). It would have been obvious to one of ordinary skill at the time of invention to insert the reactant materials of Chiharu et al. through the conduits of the electrodes in the process of Zettl et al. in order to produce single-walled nanotubes.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Peter J Lish whose telephone number is 571-272-1354. The examiner can normally be reached on 9:00-6:00 Monday through Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Stanley Silverman can be reached on 571-272-1358. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

PL

STUART L. HENDRICKSON
PRIMARY EXAMINER